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VII. *Description of a new Dipping-needle. By Mr. J. Lorrimer, of Penfacola, in a Letter to Sir John Pringle, Bart. P. R. S.*

TO SIR JOHN PRINGLE, BART. P. R. S.

SIR,

Penfacola, Sept. 13, 1773.

Redde, Feb. 2,
1775.

WHENEVER any one meets with a *terrella*, or spherical loadstone, the first thing he does is to find out its poles; and having once discovered them, he knows immediately how any small bit of needle will be affected, if it is placed upon any part of the surface of that *terrella*. The poles are most readily discovered by trying where the filings of iron, or a small bit of needle, will stand erect upon the *terrella*; and this is generally found to be upon two points which are diametrically opposite to one another. But the magnetic poles of the earth seem to be situated obliquely to one another (see the Berlin Memoirs, 1757); but where they are actually situated is hitherto unknown; whether they are upon land or water; or in either case, whether we can come nigh to them. Yet be these things as they may, it appears evident to me, that accurate observations, made as near to these magnetic poles as possible, with a good dipping-

dipping-needle, are the surest way to complete the magnetic theory of this globe, analogous to the method we pursue in examining the *terrella*. But as all the dipping-needles which I had seen, appeared to me to be very ill calculated, for the sea service at least, I contrived one upon a different plan in 1764, and had it executed before I left England, by Mr. Sisson. I have called it an Universal Magnetic Needle, or Observation Compass; because I can by it take the dip and amplitude, and even the azimuth, with only one assistant, to take the altitude for me. The needle is of the same shape and size nearly as those used now for the compasses of the royal navy, and plays vertically upon its own axis, which has two conical points, slightly supported in two corresponding hemispherical (a) sockets, which are inserted into the opposite sides of a small upright brass parallelogram, about one inch and a half broad and six inches high. Into this parallelogram is fixed, at right angles, a slender brass circle, about six inches diameter, silvered and graduated to every half degree, upon which the needle shows the dip, by a *vernier* if you choose; and this, for the sake of distinction, I shall call the circle of magnetic inclination. This brass parallelogram, and consequently the circle of inclination, also turns horizontally upon two other pivots, the one above and the other below, with corresponding sockets in the parallelogram. These pi-

(a) Mr. Sisson thinks, that these sockets were conical as well as the ends of the axis, but more obtuse than them; which seems most likely to be the case, as they seem much more likely to answer well than hemispherical sockets.

vots are fixed in a vertical brass circle, of the breadth and thickness of two-tenths of an inch, and of such a diameter, as to allow the circle of inclination and the parallelogram to move freely round within it. This second circle I shall call the general meridian. It is not graduated, but has a small brass weight fixed to the lower part of it, to keep it upright; and the circle itself is screwed, at right angles, into another circle, of equal internal diameter, of the same thickness, and twice the breadth, which is silvered and graduated on the upper side to every half degree. It represents the horizon, as it swings freely upon gimbals, and is always nearly parallel to it. The whole is contained in a neat mahogany box, of an octagon figure, with a glass plate at top and one on each side, for about two-thirds down. That part of the frame which contains the glass lifts off occasionally. The whole box turns round upon a strong brass center, fixed in a double plate of mahogany, glued together cross-ways, to prevent its warping or splitting; and this again is supported by three brass feet, such as are used for the cases of table knives, frosted that they may not easily slip, if the vessel should have any considerable motion. It has another square deal box to lock it up in, to preserve the glass, &c. when it is not wanted for use.

The use of this instrument is very plain, as the inclination or dip is at any time apparent from inspection only, and also the variation, if the frame is turned round till the great vertical circle lies exactly in the plane of


the true meridian : for the circle of inclination, being always in the needle's vertical plane, the edge of it will evidently point out upon the horizon, the variation E. or W. But at sea, when there is not too much motion, you turn the frame round, till the vertical circle is in the plane of the Sun's rays; that is, till the shadow of the one side of it just covers the other, and the edge of the circle of inclination will then give the magnetic amplitude, if the Sun is rising or setting; but the azimuth at all other times of the day, and the true amplitude or azimuth being found in the usual way, the difference is the variation. If the motion is considerable, observe the extremes of the vibration, and take the mean for your magnetic amplitude or azimuth. When the Sun does not shine so bright as to give a shadow, you can set the brass circle in a line with his body, if he is at all visible by your eye. The principal advantage at first aimed at in this compass, was to contrive a dipping-needle, which should be sufficient for making observations at sea. As those needles, to be of use, must be placed, by some means or other, in such a manner as that all their vibrations shall be made in the true magnetic meridian, North and South, otherwise they are good for nothing. For if one of them is placed at right angles, across the magnetic line, it will stand perpendicularly up and down in any part of the world; the least dip, therefore, is always in this magnetic line. But the only method of setting a dipping-needle at sea, was to place it in a line with the common compass needle; and this must be

very

very inaccurate, if they are at any considerable distance one from the other; or if they were near, the two needles would influence one another, and neither of them could be true: nay, supposing them for once to be properly placed in this line, the least motion of the ship throws them out again. But this instrument has a constant power in itself, not only of setting itself in the proper position, but also of keeping itself so; or of restoring itself to the same situation, if at any time it has lost it; and it is curious to see how, by its double motion, it counteracts, as it were, the rolling motion of the vessel. I have only one thing farther to observe, that as it is impossible for human hands to make any instrument mathematically true, so when we have two graduations to look to, as in the present case, one on the North, and the other on the South of the needle, we ought to attend to both, and take the medium for the true dip or variation pretty nearly. But in this compass there is another method of examining the observations. Take a good artificial magnet, and on the outside of the compass-box, point one end of it towards the needle, and by moving your magnet you may thus guide the north-end of the needle round to the south; or, *vice versa*, without opening your compass-box. The magnet being then laid aside, the needle will come to its true position, after a few vibrations: but as both the needle and the circle of inclination are now reversed^(b), it will not point exactly to the

(b) Mr. LORIMER means, that the magnet should be applied in such manner as to turn the parallelogram and circle of inclination half way round horizontally, so that that end of the axis of the needle which before pointed to the west, shall now point to the east.

same division as before; yet a mean of the two will be the truth, as nearly, I believe, as it is possible for any instrument to give it.

Quere 1st. May not a part of this small difference be attributed to the direction of the magnetic influence (whatever that be) in the steel bar? and if such an experiment could be tried upon the present azimuth compasses, is it not probable, that the variation in them would be at least as sensible? Quere 2d. May not this be the cause that two of the best of them will differ a small matter from one another? Quere 3d. Would the ends of the needle being made thus , instead of the square form be, in some measure, a remedy for this small variation?

I am, most respectfully, SIR,

Your most obedient humble servant,

J. LORIMER.